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leaves. The fourth plant developed mosaic again, but not as seriously as before treatment. Healthy plants inoculated with the juice of leaves from the first three plants contracted the disease almost without exception, as they did from the fourth plant, which showed the disease. Here we have a case of *apparent* recovery, but the plants still contained the active principle of the disease in a very infectious form. The percentage of infection from these plants is given below:

From plant No. 1, 8 healthy plants developed 6 cases of mosaic in 18 days, 75 per cent.

From plant No. 2, 8 healthy plants developed 8 cases of mosaic, or 100 per cent.

From plant No. 3, 10 healthy plants developed 9 cases, or 90 per cent.

From plant No. 4, which showed a slight trace of the mosaic, 100 per cent. infection was secured.

These results show that when blue light is used, there is a suppression of the leaf color variation more or less permanent in character, the treated plants with one exception showing no typical symptoms of the disease for at least two weeks subsequent to the removal of the hoods. It can not be said, however, that the disease was controlled, as inoculation of healthy plants with juice from diseased leaves produced the trouble in nearly every case. The active principle of the disease was still present in apparently normal, fully recovered leaves, and was highly infectious.

These experiments were repeated and the same results obtained in practically every case. They do not entirely harmonize with the results obtained by Lodewijks, but do in so far as the plants under the blue hoods showed an *apparent* recovery; but as Lodewijks, so far as the writer is aware, did not try any re-inoculation experiments, he overlooked the fact that the active principle might still be contained in the leaves and that it might be capable of transmission. This is clearly shown in the above experiments, and there is no doubt that the active principle of the disease is still present in plants treated in this manner. It is evident that the treatment of plants as above recorded does not destroy the

active principle, whatever may be its character, the treated leaves apparently still containing it, very probably in the same manner as do parts of the plant which do not show visible symptoms of the disease normally, such as the stem, lower leaves and roots—the juices of which are often highly infectious.

More detailed results of these experiments are to be published later in connection with a report of work on the mosaic disease of tobacco as carried on at this station.

GEORGE H. CHAPMAN

MASSACHUSETTS AGRICULTURAL  
EXPERIMENT STATION

### THE NATIONAL ACADEMY OF SCIENCES

At the annual meeting of the Academy to be held on April 17, 18 and 19, the program of the scientific sessions will be as follows:

Auditorium, National Museum. Public scientific session for the reading of papers.

*On Permeability of Endothelia:* S. J. MELTZER.

*The Influence of Morphin upon the Elimination of Intravenously Injected Dextrose:* I. S. KLEINER and S. J. MELTZER.

*The Sex of a Parthenogenetic Frog:* JACQUES LOEB.

It seemed of interest to determine the sex of frogs produced by artificial parthenogenesis. The first experiments in this direction by Loeb and Bancroft had been made on a frog and a tadpole of about four months old. The gonads of both sexes contain eggs at that age and it was only with approximate certainty that the sex of our parthenogenetic specimens could be determined. As far as we were able to judge the sex in the two cases referred to was male. The writer has since succeeded in keeping a number of parthenogenetic frogs alive for about one year and one of them was recently killed and the gonads sectioned and examined. They were found to be testicles containing well-developed spermatozoa. This confirms the former statement of Loeb and Bancroft that the frogs produced by artificial parthenogenesis are males.

*Finer Mechanisms of Protection from Infection:* SIMON FLEXNER.

The biological phenomena associated with recovery from bacterial infections among animals remained largely unexplained until the era which

ushered in the antitoxic treatment of certain bacterial diseases and notably diphtheria and tetanus. Since then, data have accumulated rapidly. No difficulty is encountered in explaining antitoxic immunity, so called, which is a process essentially of neutralization—of a toxic body with the antitoxic antagonist. But no such simple explanation suffices to account for the process through which living bacteria and not their waste products alone are destroyed. Several independent reactions are distinguishable: the assembling (agglutination) of the bacteria, their englobing by cells (phagocytosis), and their disintegration inside and outside of cells (bacteriolysis). The processes are partly inherent in the animal host, partly subject to augmentation. The experiments to be described deal with the finer mechanism of the disposal of bacteria through phagocytic activity and the action upon the mechanism of antiseptic chemicals which have been or conceivably may be recommended for the treatment of the bacterial infections because of the possession of bactericidal properties.

*The Distribution of the Chondriosomes to the Spermatozoa in Scorpions:* EDMUND B. WILSON.

The spermatozoon carries into the egg two kinds of bodies that have been supposed to play a definite part in heredity; these are the chromosomes and the chondriosomes, the former belonging to the nucleus, the latter to the protoplasm or cytoplasm. The chromosomes (with certain specific exceptions) undergo in general an accurately equal distribution to the germ-cells; whether this is also true of the chondriosomes is not certainly known, though an approximately equal distribution undoubtedly occurs in some cases. In the Arizona scorpion, alone among animals thus far examined, an accurate quantitative distribution of the chondriosome-material may be demonstrated owing to the fact that prior to the spermatocyte-divisions all this material becomes concentrated in a single, definite body in the form of a ring. This body, a new type of chondriosome, divides somewhat after the fashion of a heterotype chromosome-ring, each spermatid receiving exactly one fourth of its substance. In the California scorpion the phenomena offer a remarkable contrast to this, agreeing in the main with the European form *Euscorpium carpathicus* as described by Sokolow. The ring is here absent, its place being taken by about 24 separate, hollow spheroidal bodies that show no evidence of division at any time and establish no definite relation to the

spindle, but are passively segregated by the spermatocyte-divisions into four approximately equal groups. Each spermatid thus receives as a rule six, not uncommonly five, rarely seven of these bodies, which give rise to the nebenkern like the products of the ring in the Arizona form. In both cases the chondriosome-material has the same origin, seems to play the same part in the formation of the spermatozoon (nebenkern, envelope of the flagellum) and shows the same staining reactions (Benda method). Interesting questions are thus raised concerning the principle of genetic continuity as applied to the chondriosomes or to other specific cell-components.

*Further Studies of the Protein Poison:* VICTOR C. VAUGHAN.

In 1903 Wheeler and I discovered a poisonous group in the protein molecule. This work has been extended by my students and myself and confirmed by others. Since my latest publication on this subject, the following new facts have been discovered in my laboratory: (1) *Skin Reaction*.—When a drop of an aqueous solution of the poison is placed on the normal skin and the epidermis covered by the drop abraded, there results a local inflammatory process. Within a few minutes the skin about the point becomes edematous, resembling a hive, and later develops a redness which gradually fades. This reaction is similar to the specific reactions which may be developed in certain diseases and develops in the skin of normal individuals because the poison has already been set free in vitro. (2) *Absorption from the Alimentary Canal*.—I have stated that the protein poison is harmless when taken by the mouth for two reasons: (1) it is broken into harmless groups by the digestive ferments and (2) it diffuses through the intestinal walls too slowly to have any deleterious effect. We have found that when given in relatively large amounts, especially on an empty stomach, the protein poison may be absorbed in sufficient quantity to cause death from either acute or chronic intoxication. In the latter, a typical and marked fatty degeneration of the liver and kidneys results. Moreover, we have demonstrated that in both acute and chronic intoxication the poison may be detected in the liver, kidneys, lungs, brain and other tissues. It can be extracted and its action demonstrated by intravenous injection in guinea-pigs. (3) *Combination with Proteins*.—The protein poison combines with certain proteins and in these combinations the acidity of the poison and its toxicity are modified.

## SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC

Arranged by W. M. Davis

(By invitation of the Program Committee)

*On Exploration of the Pacific:* W. M. DAVIS.

The unsolved problems of the Pacific can not be settled by a continuation of independent and short-lived explorations, such as have heretofore been undertaken. Future work should be broadly areal, rather than local as on single islands, or linear as in single voyages. It should be continuous through ten or twenty years, so that its scientific directors may repeatedly inspect the uncertain elements of their work, and thus gain in the earlier years the expertness necessary for the critical study of the most difficult problems through the later years of their explorations. The type of investigation needed in various branches of science is furnished by the repeated traverses of the Pacific on many interwoven routes in the course of the magnetic survey of the earth by the Carnegie Institution of Washington. Problems of a century or more ago were bravely attacked in adventurous voyages of discovery. Problems of a generation ago were earnestly approached by less adventurous and more scientific voyages of investigation. But the demands of modern science have become exacting. So delicate are the variations of temperature and density in ocean water at various depths, so elaborate are the phenomena of oceanic and atmospheric circulation, so complicated are the details of shoreline features by which changes in the level of the land or reversed changes in the level of the ocean are to be inferred, so involved are the biological problems of pelagic islands, that the detached facts of earlier scientific voyages must now be supplemented by more continuous bodies of facts. The development of a comprehensive plan for the exploration of the Pacific is worthy of the National Academy of Sciences, and it is to be hoped that the commendation of such a plan by the Academy may lead in the next five or ten years to its realization.

*The Importance of Gravity Observations at Sea in the Pacific:* J. F. HAYFORD.

*A New Method of Determining Gravity at Sea:* L. J. BRIGGS.

The method employed in measuring  $g$  at sea consisted in observing the height of a mercurial column in vacuo necessary to maintain a confined mass of gas at a constant volume when kept at a constant temperature. The mercurial column is contained in a capillary glass tube bent into a zigzag or spiral above the gas chamber, and expanding at the top of the capillary into an evacu-

ated observing bulb which contains a fixed iron point. The capillary tube is sealed through the upper end of the gas chamber, the lower end of the capillary tube dipping beneath mercury in the bottom of the chamber. The pressure of the nitrogen in the gas chamber (about 72 cm.) is so adjusted that at the temperature of melting ice the mercury surface at the top of the column is in contact with the fixed point at the center of the evacuated bulb. The gas chamber is then sealed. The zigzag in the glass capillary makes it possible to raise or lower the observing bulb slightly with reference to the gas chamber, the motion being controlled by a micrometer screw mounted on the gas chamber. In making an observation, the apparatus is adjusted to a vertical position in a bath of melting ice, and the observing bulb is raised or lowered until the mercury is in grazing contact with the fixed point. Under these conditions the quantity of mercury in the observing bulb is always the same, so that the quantity of mercury in the gas chamber is also constant. The gas volume is therefore constant and the measurements are made at constant pressure. The relative value of  $g$  at two stations is therefore inversely proportional to the height of the mercurial column at these stations. The height is represented by the micrometer reading plus a constant term determined from a manometer connected with the gas chamber at the time of sealing. On shipboard the ice tank is hung in gimbals which are suspended from spiral springs. The apparatus has been used in measurements from Sydney to San Francisco, and from New York to San Francisco, via Panama. The mean probable error of observations at base stations during the latter voyage, in which three instruments were used, was 1 part in 60,000. Apparent anomalies were observed at sea on both sides of the Isthmus of Panama, along the coast of Lower California and off the California coast near San Francisco.

*The Problem of Continental Fracturing and Diastrophism in Oceanica:* C. SCHUCHERT.

A presentation of the problems connected with Oceanica, the most mobile region of the Pacific Ocean, and with the fracturing and foundering of Australasia within the area.

*Petrological Problems in the Pacific:* J. P. IDINGS.

A number of geological problems of the first magnitude are also petrological ones since they involve the material of the lithosphere, which is only known through a study of the rocks.

Throughout the vast extent of the Pacific Ocean scattered volcanic islands furnish us with material evidence of the composition of the suboceanic portions of the lithosphere. A thorough investigation of the rocks of these islands will contribute to our knowledge of the distribution of various igneous rocks, that is, to the problem of petrographical provinces which involves the question of lateral heterogeneity of the earth.

Closely allied to this is the problem of isostasy, or the relation between the major features of the relief on the earth's surface and the density of the underlying lithosphere. Igneous rocks from continental regions should average lighter than those from deep oceanic regions. Preliminary estimates appear to confirm this expectation, but much more data regarding the rocks of deep sea islands are needed to establish the relationship.

An exhaustive study of the rocks of the Pacific islands will determine the character of each group as either the summits of volcanoes built up from the sea bottom or partly submerged remnants of a former continental area.

#### *Afternoon Session*

2.30-6.00 P.M.—Auditorium, National Museum.

*A New Form of Metamorphism:* ARTHUR KEITH (introduced by GEORGE F. BECKER).

Many Appalachian rocks are known which appear to be massive plutonics and have been called quartz diorite. Some evidence against this was known from the first, but their metamorphic nature is now considered settled. These rocks form bodies with shapes usually somewhat elliptical, but also lenticular, in sheets or dike-like masses. Their larger relations are: (1) gradation into the enclosing rocks; (2) occurrence only in graywacke or similar rocks; (3) thickness, rarely over three feet; (4) lack of igneous rock in the same region; (5) presence at many horizons; (6) occurrence over thousands of square miles. The principal minerals are quartz, hornblende or biotite, garnet, albite and oligoclase, the most conspicuous being hornblende, biotite and garnet. These obliterate the older minerals, and their prisms are disposed at random in marked contrast with the older parallel structures. The most striking assemblage is a spheroid composed of concentric shells of different mineral contents. These rocks were metamorphosed from graywacke or similar rock under heat and pressure but no movement. They raise anew the old question of the formation of igneous rocks from sediments. It appears, however, that they were not fused as a

mass, but that their individual minerals grew through the agency of solutions. The process is of wide extent and is available as an accessory in forming plutonic rocks.

*Contributions to the Petrology of Japan, Philippine Islands and the Dutch Indies:* J. P. IDINGS and E. W. MORLEY.

Volcanic rocks have been collected from thirteen active volcanoes and from other localities in Japan, and chemical analyses have been made of sixteen of them. The igneous rocks of Luzon, P. I., were collected and studied, and six analyses made. They bear strong resemblances to rocks of Japan. In the Dutch Indies the leucitic rocks of Java, Bawéan and Celebes were collected, together with the associated lavas and intrusive rocks. Of these twenty-nine have been analyzed, besides seven from Timor and Sumatra. The leucitic rocks of Celebes were found to be much more extensive than heretofore supposed.

#### SYMPOSIUM ON THE EXPLORATION OF THE PACIFIC (Continued from the Morning Session)

*The Extent of Knowledge of the Oceanography of the Pacific:* G. W. LITTLEHALES.

The accumulated oceanographical observations in the Pacific relate principally to the surface and the bottom. The intermediate depths have been little investigated. The materials from centuries of voyaging and from the expeditions for sounding the ocean sent forth since the last quarter of the nineteenth century, when deep-sea soundings first began to be taken in the Pacific, have provided information of the distribution of barometric pressure and winds over this vast tract and also of the general aspects of surface circulation, temperature and salinity. The manuscript sheets of the United States Bathymetrical Chart, containing all the authentic deep-sea soundings, are offered in evidence to show the extent to which the basin has been sounded and the distribution of bottom deposits made known, and to prove the inadequacy of existing measurements to define the contours of configuration beyond the continental shoulder. In the North Pacific there is a tract twice as large as the United States which has been crossed by only a single line of soundings at intervals about 250 miles wide apart; and a number of instances exist in which tracts as large as the United States remain entirely unfathomed. The deposits on the floor of the ocean have generally been penetrated only to the depth of a few inches, and little is known of their thickness or stratification. Of the variations, from

season to season and from year to year, of the temperature, salinity and gas-content in the depths of the Pacific, no observations have been made—not even in the lesser depths throughout which extends the interchange of heat between the ocean and the atmosphere; and consequently there is no knowledge of the import of such changes upon the variations of climate and of physical and biological oceanography. The observational foundation for investigating the ocean from the standpoint of thermodynamics does not exist.

*Marine Meteorology and the General Circulation of the Atmosphere:* C. F. MARVIN.

The proposal to organize a marine exploration of the Pacific ocean for making carefully planned scientific observations in oceanography, gravity, atmospheric and related subjects claims the great interest of the Weather Bureau and affords an opportunity to utilize the meteorological data now in the archives of that institution and hereafter to be collected by it in the discussion of observations to be collected during the expedition. Reports are now received by the Weather Bureau from 175 vessels traversing the main routes mostly of the Pacific oceans. Weather maps of the oceans can be constructed on some occasions at least, and in any case it may fairly be said that the proposed exploration must of necessity contemplate supplementing the meteorological data it collects by the more or less simultaneous information of related nature collected from every other vessel then at other points over the adjacent oceans. The greatest need in atmospheric of the present time is free air data. To secure these in fullest measure will require, at times at least, two points of observation one or two miles apart, for the purpose of triangulation as it were, and the expedition should be planned to provide for such a possibility as well as that of following free balloons by the aid of a small high-speed launch or sister ship of appropriate character. The meteorological observations that might form the working program of the expedition will be indicated and the personnel suggested. The paper will refer to or briefly summarize the data obtained from aerological work in the United States and draw inferences therefrom as bearing upon accepted theories of the general circulation of the atmosphere.

*On the Distribution of Pacific Invertebrates:* WM. H. DALL.

Mr. Dall will point out the importance of the distribution of marine invertebrates, as one of the keys to the former distribution of land masses,

and to our very imperfect knowledge of their distribution in the Pacific. Certain species, usually those inhabiting the reefs and comparatively shallow water, are very widely distributed over the region usually referred to as Indo-Pacific; but when a careful collection of the species belonging to any isolated island or group is available it becomes evident that a large proportion of them are local and combine to form a local fauna. A knowledge of these faunas is necessary before any satisfactory discussion can be had of the presumably Tertiary fossiliferous deposits which are found fringing the more elevated Pacific islands. The land shells of the Hawaiian and Tahitian groups indicate a high antiquity for their isolation according to Pilsbry, the most eminent student of these animals. The facies of the Tertiary fossils obtained by Ochsner on the Galapagos Islands indicates a derivation from the American rather than the Indo-Pacific fauna, with which the recent invertebrates are commingled. These facts indicate the interest which attaches to a wider knowledge of the Pacific faunas.

*Land Mollusca of the Pacific:* H. A. PILSBRY.

Present knowledge of Pacific land snail faunas is fairly adequate only for the Hawaiian and Society groups, but fragmentary data are available for many other islands. Some distinctively continental families extend as far out as Fiji, the western Carolines and the Bonin Islands. Beyond this there is another fauna, its striking feature being the absence of all highly evolved continental groups. This Pacific fauna consists partly of groups known by paleontological evidence to be old (such as the Succineidae and Endodonts), and partly of a series of families having a primitive organization resembling aquatic air-breathing snails; *Achatinella* and *Partula* being the best known representatives. These hold a relation to the higher land snails analogous to that of the monotremes to placental mammals. Their adaptive modifications often parallel those of fundamentally diverse continental snails. The hypothesis that Pacific snails reached the islands by over-sea drift leaves the absence of higher snails unexplained. The distribution of the faunas and their antique aspect suggest that there were large antecedent land masses, upon which the present relatively modern volcanic islands were superposed during subsidence.

*Marine Algæ of the Pacific Islands:* W. G. FARLOW.

In any future expedition to the Pacific Islands

the plankton species should, of course, be collected wherever and whenever possible. In our present fragmentary knowledge of the littoral and sublittoral flora of the Pacific, it is not possible to say just what are likely to be the most important general problems ultimately to be investigated. What is first needed is a more detailed knowledge of the flora of certain centers than we at present possess. A practical question is what regions can be better explored by a special expedition and what regions can be sufficiently well studied by resident algologists. In the latter category should be included the islands on the western limit as the Bonin and Loochoo Islands and Formosa, now studied by the Japanese and the outlying Sandwich Islands where large collections have recently been made by some of our own algologists. The flora of the Philippines, although not well known, can be studied from collections easily made by local botanists. From the islands in Polynesia proper, as the Fiji and Samoa Islands which lie on the route from Australia to North America we have a certain amount of material which has been studied by experts, as Harvey and Grunow, but of the islands to the east of the Friendly Islands we have, with the exception of Tahiti, almost no knowledge. It therefore seems to be advisable that an exploring expedition should make the Fiji Islands or Samoa a center from which to explore the islands to the eastward as far as the Marquesas Islands. If means permit, starting from the same base, it would then be desirable to visit the islands extending as far to the northwest as the Caroline and Ladrone Islands, of whose flora we have a partial knowledge from collections made by some of the exploring expeditions of the last century.

*Problems of the Pacific Floras:* D. H. CAMPBELL.  
*The Pacific as a Field for Anthropological Investigation:* J. W. FEWKES.

There is no large island in the Pacific ocean which was uninhabited by man when discovered by Europeans, and several show evidences of human occupation for a considerable antiquity. Our knowledge of the Polynesians is very deficient. This race presents many anthropological problems of great interest. From what direction, how and when did man migrate across the Pacific from one isolated island to another; how many traits of ancestral culture still remain, and how much have they been modified by oceanic insular environment, are questions which await intensive work in this field before they can be satisfactorily

answered. Where there are so many unsolved problems, it is almost impossible to single out one in preference to others; but perhaps that which appeals most directly to us is the part the Pacific may have played in the aboriginal peopling of America. We know next to nothing of the physical features, much less of the language and comparatively little of the material culture of this race. Our knowledge of the history of the inhabitants of the Pacific islands is small. There are archeological remains scattered from Java to Easter Island. Our knowledge of the physical anthropology, linguistics and ethnology of Australia is very limited. Much that has been published ought to be critically examined and amplified by intensive studies. Anthropological work in the Pacific will be a service to science by shedding a flood of light on culture history. The harvest is sure to be great if we can find the man competent to gather it.

#### PAPERS OF THE REGULAR PROGRAM

*Hereditary Transmission of Defects resulting from Alcoholism.* (By invitation of the Program Committee.) CHARLES R. STOCKARD.

*Recent Observations on the Activity of some Glands of Internal Secretion:* W. B. CANNON.

Studies on conditions of activity of the adrenal glands have shown that during emotional excitement they secrete into the blood a substance which affects the bodily organs in a manner simulating the nervous influences of strong emotions. Electrical studies of the thyroid gland indicate that it also is brought into action in great emotional excitement, both by nervous and by chemical stimuli. These glands have a routine function without which certain bodily processes are not normal. They may also be reasonably regarded as having emergency functions which are called forth in times of emotional stress and are important for the needs of the organism (*e. g.*, for struggle) under such circumstances.

*Studies in the Water Content of the Nervous System:* H. H. DONALDSON.

8:00 P.M.—Auditorium, National Museum.

First William Ellery Hale Lecture, by Henry Fairfield Osborn, president of the American Museum of Natural History. Subject: "The Origin and Evolution of Life on the Earth." (Illustrated.)

The lecture will be followed by a *conversazione* in the art gallery of the museum. All members of the scientific societies of Washington, with ladies,

are cordially invited to attend both lecture and conversazione. No cards are necessary.

TUESDAY, APRIL 18  
Morning Session

10:30-12:45 A.M.—Auditorium, National Museum. Public scientific session for the reading of papers.

*Some Recent Results of Solar Research:* GEORGE E. HALE.

The new results include photographs and stereograms of the solar atmosphere made with a 13-foot spectroheliograph; part of a new map of the sun-spot spectrum, on a scale of one centimeter to the angstrom, showing the magnetic phenomena of sun-spots; illustrations of the Stark effect for hydrogen and lithium; and observations indicating that the northern and southern sun-spots of the present cycle, irrespective of latitude, are opposite in magnetic polarity to the corresponding spots of the preceding cycle, while the chromospheric vortices associated with spots did not undergo a similar reversal in sign at the minimum. *An Investigation of the Suggested Mutual Repulsion of Fraunhofer Lines:* CHARLES E. ST. JOHN (introduced by G. E. HALE).

Those who assign an important rôle to anomalous dispersion in the solar atmosphere deduce from the theory a mutual influence between the components of close pairs of Fraunhofer lines, which operates to increase their distance apart. Investigations now nearing completion show that the relative positions of lines in close solar pairs conform to their relative positions in terrestrial spectra to the same degree of precision as free-standing solar lines which are not under the influence of neighboring lines, and the violet and red components are not displaced to the violet and red respectively as the theory demands that they should be in the solar spectrum.

*Anomalous Dispersion Phenomena in Electric Furnace Spectra:* ARTHUR S. KING (introduced by G. E. HALE).

Strong anomalous dispersion effects have been produced by passing white light through metallic vapors in an electric furnace. A study under high dispersion of spectrum lines very close together gave no indication of the mutual repulsion predicted by Julius when one of the lines in question shows high anomalous dispersion. Other experiments, in which the wave-length of a line was measured when alone and also when very close to a strong line of another element, gave no difference greater than 0.001 angstrom.

*Illustrations of the New Spectroscopic Method of Measuring Stellar Distances:* WALTER S. ADAMS (introduced by G. E. HALE).

The method of determining the actual light emission of a star from the appearance of the absorption lines in its spectrum has proved a valuable way of measuring stellar distance, since the difference between the actual and apparent brightness of a star depends only on its position in space. The new method has been used to determine the distance of a remarkable pair of faint stars in the southern sky, showing that the components move in parallel paths at the greatest known stellar velocity—about 600 km. a second. Another interesting application relates to the total light emission of the sun. By simply comparing the relative intensities of five lines in the solar spectrum the apparent brightness can be estimated with an accuracy comparable with that of direct photometric measurement.

*Some Results with the New 10-inch Photographic Telescope:* HARLOW SHAPLEY (introduced by G. E. HALE).

The new Cooke photographic triplet of 10 inches aperture, focal length 45 inches, has been used with a 15-degree objective prism to photograph spectra of faint stars. The scale is three minutes of arc to the millimeter and a single plate covers nearly 400 square degrees. As many as 10,000 spectra have been photographed at one exposure. The instrument has been applied to the study of Cepheid variables, and the spectra of about a dozen have been found to vary periodically with the light.

*The Pyranometer, an Instrument for the Measurement of Sky Radiation:* C. G. ABBOT AND L. B. ALDRICH.

The authors have perfected an instrument to measure the radiation originally forming a part of the beam of rays from the sun, but which reaches the observer by scattering from all parts of the sky. The instrument can also measure the radiation outward toward the sky and space at night, comprising those long wave-length radiations which are purposely excluded in the daylight measurements. For the first purpose the instrument is provided with an optically figured hemispherical shell of ultra-violet crown glass about 2 mm. thick. The diameter of the shell is about 25 mm. For nocturnal radiation measurements this shell is not employed. The horizontal measuring surface is a thin blackened strip of manganin about



6 mm. long, 3 mm. wide, and  $3/1,000$  mm. thick, placed centrally and level with the surface of a circular nickel-plated copper plate 12 mm. thick, 75 mm. in diameter. The manganin strip is electrically insulated from the copper plate by means of thin strips of mica which come exactly to the common surface of the plate and strip. Underneath the manganin strip are cemented two thermo-elements of tellurium and platinum joined in series, and whose cool junctions are embedded in opposite halves of the copper plate. A polished nickeled hemispherical shutter encloses the outside of the glass hemisphere, and when it is open the radiation from the sky passes through the hemisphere, falls upon and is absorbed by the upper surface of the manganin strip. Thus the thermo-elements are warmed and deflection of the galvanometer connected with the apparatus would ensue. But this is reduced to zero by means of an auxiliary current supplied by a potentiometer arrangement. Having secured the balance by means of the potentiometer circuit, the shutter is now closed and a heating current is applied to the manganin strip until the temperature is again raised so that with the same potentiometer current the galvanometer again stands at zero. In these circumstances, as in the Ångström pyrheliometer, the energy of the current expended in heating the strip is equal approximately to the energy of the sky radiation which heated the strip before. This apparatus has been used with excellent results on the snow, the sky, the sky and the sun, and the sun alone. In the latter case the instrument was compared with a standardized silver-disk pyrheliometer. Corrections having been made for the inclination of the rays to the surface of the horizontal sky radiation instrument, reflection of glass, and imperfect absorption of the lamp-black close agreement was found between the results derived from the two kinds of apparatus. We are of the opinion that with this apparatus the sky radiation can be measured to within perhaps 2 per cent. The reflecting power of snow for total solar radiation was found to be 70 per cent. In using the apparatus for the measurement of nocturnal radiation the glass hemisphere is removed. Upon the opening of the shutter the strip cools and thereby a deflection is produced in the attached galvanometer. This deflection, however, is brought to zero by introducing in the strip a heating current such that the temperature is restored to what it was before the shutter was removed. It is plain that the instrument may also be used

for the measurement of the radiation of inclosures at fixed known temperatures which might be regarded as perfect radiators. We hope to make experiments of this kind in the effort to aid in the determination of the constant of Stefan's fourth power formula for the radiation of black bodies.

*Invisible Companions of Binary Stars:* G. C. COMSTOCK.

A large proportion of the visible stars are shown spectroscopically to be accompanied by companions not separately visible. In a very limited number of cases, such companions have been otherwise found. The presence of such invisible companions is possibly, or even probably, a normal stellar attribute. Aside from spectroscopic investigation, and in a field not accessible to it, the most promising method of search for such bodies is to be found in the disturbances produced by them in the motions of binary systems. This has been realized in a very few cases, *e. g.*, Zeta Cancri. The present paper suggests a simple method of testing suspected cases of this kind and shows by its application to Zeta Herculis that this star is probably a triple system in which the relative masses are of the order 100:10:1. The two smaller bodies are separated by only a twentieth of a second of arc.

*Theory of Electric Conduction in Metals:* EDWIN H. HALL.

In July, 1914, the author published<sup>1</sup> a paper in which he reached the conclusion that the so-called free electrons have little to do with electric conduction in metals but have an important function in thermo-electric action. In 1915 he made the suggestion<sup>2</sup> that the metal ions,—which are probably equal in numbers to the free electrons in a metal—may be of great effect in electric conduction. The idea is that during a collision between an atom and an ion an electron may be transferred from the atom to the ion by the action of a potential gradient due to an externally applied E.M.F., whereas in the collision of two atoms the electron would not pass. It can be shown that a comparatively small number of ions might serve to maintain a very powerful current. Some progress has been made in adapting this general theory to the requirements of Ohm's law and the known temperature relations of electric conduction in metals.

<sup>1</sup> *Proceedings of the American Academy of Arts and Sciences.*

<sup>2</sup> In *Il Nuovo Cimento*, the first number for 1915.

*The Evolution of the Stars*: F. R. MOULTON.

*The Minor Planets discovered by James C. Watson*: A. O. LEUSCHNER, Watson Medallist.

*Afternoon Session*

2:30-6:00 P.M.—Auditorium, National Museum.

*Biography of Professor Theodore Nicholas Gill*: WM. H. DALL. (By title.)

*Biography of Professor Edward Singleton Holden*: W. W. CAMPBELL. (By title.)

*Biography of Professor Simon Newcomb*: W. W. CAMPBELL. (By title.)

*Report of the Work of the Committee upon the Panama Canal Slides*: CHARLES R. VAN HISE, Chairman.

*The Mechanics of the Panama Slides*: H. FIELDING REID.

*The Present State of Knowledge of the Extreme Ultra-Violet*: THEODORE LYMAN, Director Jefferson Physical Laboratory, Harvard University. (By invitation of the Program Committee.)

The paper aims to present a résumé of the results which have been obtained in the region of very short wave-lengths since the researches of Schumann came to an end. The limit of the spectrum and the means which may be used to extend it, form the dominating feature of the article.

*A Redetermination of  $e$  and  $N$* : ROBERT A. MILLIKAN.

In view of the far reaching significance of the electronic charge and the apparent adaptability of the "droplet method" to its very exact determination, an effort has been made during the past year to push this method to the limit of its possible precision. Droplets made from different substances and falling in different gases have been used. All the constant factors involved in the experiment have been redetermined. Details of the measurements will be published elsewhere. The final result is in exceedingly close agreement with the value obtained by the author and published in 1913, namely  $e = 4.774 \times 10^{-10}$  electrostatic units.

*The Relation of Investigational Work to the Enforcement of the Food and Drugs Act*: CARL L. ALSBERG, Chief of the Bureau of Chemistry, United States Department of Agriculture. (By invitation of the Program Committee.)

*Recent Exploration on the Mesa Verde National Park, Colorado*: J. WALTER FEWKES.

Wherever we turn in certain sections of our southwest, we find mounds, ruins and evidences of prehistoric buildings. Their very multiplicity

tends to confuse the mind, especially when it attempts to interpret their significance in culture history. The first step in anthropology, as in other natural sciences, is classificatory: Prehistoric culture is largely determined by architecture and ceramics. We need a reliable classification of these data. Manifestly linguistics or even physical anthropology are not adequate to give a satisfactory picture of the culture history of the people who inhabited a large part of our southwest. We must look to archeological data, especially architecture, for a knowledge of an unlettered prehistoric people. The object of the present communication is to record the progress of archeological work in the Mesa Verde National Park for the purpose of enlarging our knowledge of the prehistoric culture of southwestern Colorado. Incidentally it is an endeavor to show what the author regards as the scientific method of excavating southwestern ruins and of preparing and preserving them for future students. It has special reference to the field work in the summer of 1915 and is a continuation of work already accomplished in the years 1908, and 1909, when two large ruins—Spruce-tree House and Cliff Palace—were excavated and repaired to serve as type ruins of cliff dwellers. The plan of the field work in 1915 was the excavation of a mound on the point of the mesa opposite Cliff Palace. It was believed that a ruin belonging to a type unlike cliff dwellings was covered by this mound. The work was successful, and not only a new type of building was exposed, but the features brought to light indicate that it was constructed for rites connected with worship, in which the sun plays a prominent rôle. The method of excavation, repair and preservation of Sun Temple, as well as unique features developed, will be illustrated by lantern slides.

*Further Evidence on the Nature of Crown Gall and Cancer and that Cancer in Plants Offers Strong Presumptive Evidence both of the Parasitic Origin and of the Essential Unity of the Various Forms of Cancer in Man and Animals*: ERWIN F. SMITH.

WEDNESDAY, APRIL 19

1:00 P.M.—Auditorium, National Museum.

Second William Ellery Hale Lecture, by Henry Fairfield Osborn, President of the American Museum of Natural History. Subject "The Origin and Evolution of Life on the Earth." (Illustrated.)